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Integrating six-minute walk test with spirometry for functional assessment of lung disease

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Abstract

Background: Spirometry is the standard method for assessing pulmonary function, but it does not fully capture functional exercise capacity. The six-minute walk test (6MWT) provides an integrated measure of cardiopulmonary and musculoskeletal performance during submaximal exercise. **Aim:** To evaluate the six-minute walk test as a functional marker of spirometric lung function in a prospective cohort.

Methods: This prospective observational study was conducted at Sree Gokulam Medical College & Research Foundation, Thiruvananthapuram, Kerala, from May to September 2025. Adult patients undergoing spirometry were enrolled. Spirometric parameters (FEV_1, FVC, and FEV_1/FVC) were measured according to ATS/ERS guidelines. The 6MWT was performed following standard protocols, recording six-minute walk distance (6MWD) and oxygen saturation. Correlations between spirometric indices and 6MWT parameters were analyzed.

Results: A total of 100 participants were studied. Mean 6MWD showed a strong positive correlation with FEV_1 (% predicted) and FVC (% predicted), and a moderate correlation with FEV_1/FVC. Oxygen desaturation during the 6MWT was significantly greater in participants with lower spirometric values.

Conclusion: The six-minute walk test correlates well with spirometric lung function and serves as a practical functional marker, complementing spirometry in the assessment of chronic respiratory disease.

Keywords: Six-minute walk test, Spirometry, Exercise capacity, Pulmonary function, Chronic respiratory disease

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Introduction

Chronic respiratory diseases reduce ventilatory reserve and limit routine physical activity, so pairing physiological assessment (spirometry) with a simple functional test can improve clinical evaluation. The six-minute walk test (6MWT) is an inexpensive, submaximal field test that captures the integrated effects of pulmonary mechanics, gas exchange and cardiovascular response in a way that often reflects day-to-day exertion better than resting measures alone [1]. Observational data in interstitial lung disease show that 6-minute walk distance (6MWD) and post-test desaturation correlate with key pulmonary function indices such as FVC and FEV1, supporting its potential as a functional surrogate of spirometric impairment [2,3]. Conversely, in some settings (e.g., pre-operative lung resection candidates) correlations may be weak, emphasizing the need for prospective, disease-specific validation of 6MWT as a marker of spirometric lung function [4]. Because 6MWT is repeatable and safe, it is useful for monitoring response to therapy and rehabilitation [1]. The aim of the current study is to prospectively evaluate whether 6MWD and oxygen desaturation during 6MWT can serve as functional markers of spirometric lung function (FEV1, FVC and FEV1/FVC) in the study population.

Methods:

This prospective observational study was conducted at Sree Gokulam Medical College & Research Foundation, Thiruvananthapuram, Kerala, from May to September 2025. After obtaining approval from the Institutional Ethics Committee, eligible participants were recruited from the outpatient and inpatient departments of respiratory medicine. Adult subjects aged ≥18 years who were clinically stable and able to perform spirometry and the 6MWT were included. Patients with acute respiratory exacerbations, unstable cardiac disease, severe musculoskeletal or neurological limitations affecting ambulation, or contraindications to spirometry were excluded. Written informed consent was obtained from all participants prior to enrollment. Baseline demographic data, clinical history, and relevant examination findings were recorded using a structured proforma.

Spirometry was performed in accordance with American Thoracic Society/European Respiratory Society (ATS/ERS) guidelines using a calibrated computerized spirometer. All tests were conducted with the participant in a seated position, wearing a nose clip, and after adequate demonstration of the maneuver. At least three acceptable and reproducible efforts were obtained, and the best values were recorded. Spirometric parameters analyzed included

forced expiratory volume in one second (FEV_1), forced vital capacity (FVC), and the FEV_1/FVC ratio. Values were expressed both as absolute measurements and as percentages of predicted values based on age, sex, height, and ethnicity. Bronchodilator testing was performed where clinically indicated, and post-bronchodilator values were considered for analysis.

The 6MWT was conducted on the same day as spirometry or within 24 hours, following ATS guidelines, along a flat, straight, indoor corridor of 30 meters. Participants were instructed to walk at their own pace and cover as much distance as possible within six minutes, with standardized encouragement provided at regular intervals. Baseline measurements of heart rate, blood pressure, oxygen saturation (SpO_2), and perceived dyspnea using the Borg scale were recorded before the test. The total six-minute walk distance (6MWD) was measured in meters at the end of the test, and post-test SpO_2, heart rate, and Borg dyspnea scores were documented. Participants were monitored for adverse events, and the test was terminated if significant desaturation, chest pain, dizziness, or other concerning symptoms occurred.

All collected data were entered into Microsoft Excel and analyzed using SPSS 22.0. Continuous variables were expressed as mean ± standard deviation or median with interquartile range, while categorical variables were expressed as frequencies and percentages. Correlation between 6MWD and spirometric parameters (FEV_1, FVC, and FEV_1/FVC) was assessed using Pearson or Spearman correlation coefficients as appropriate. A p-value <0.05 was considered statistically significant.

Results:

A total of 100 participants were included in the final analysis, with a mean age of 52.4 ± 12.6 years and a male predominance (62%). Obstructive lung disease constituted the most common diagnostic category, followed by restrictive and mixed ventilatory defects. Spirometric assessment revealed a moderate reduction in pulmonary function, with mean FEV_1 and FVC values of 63.5% and 69.1% of predicted, respectively, indicating varying degrees of ventilatory impairment among the study population (Table 1). Functional exercise capacity assessed by the six-minute walk test demonstrated a mean 6MWD of 392 ± 86 meters. A clinically relevant decline in oxygen saturation was observed following exercise, with a mean desaturation of 3.4%, accompanied by a moderate increase in perceived dyspnea as measured by the Borg scale (Table 2). These findings reflect the functional limitations experienced during submaximal exertion. Correlation analysis showed a strong positive association between 6MWD and spirometric indices. The strongest correlation was observed between 6MWD and FEV_1 (% predicted) ($r = 0.62$, $p < 0.001$), followed by FVC (% predicted) ($r = 0.58$, $p < 0.001$). A moderate positive correlation was also noted between 6MWD and the FEV_1/FVC ratio (Table 3). Additionally, oxygen desaturation during the 6MWT demonstrated a significant negative correlation with FEV_1, indicating that lower lung function was associated with greater exercise-induced hypoxemia.

Discussion:

In this prospective study, the 6MWT demonstrated a meaningful association with spirometric lung function, supporting its role as a pragmatic functional marker in routine respiratory care [5]. We observed a strong positive correlation between 6MWD and FEV_1 (% predicted), followed by FVC (% predicted), while the relationship with FEV_1/FVC was moderate, indicating that walk performance reflected both airflow limitation and reduced ventilatory reserve across mixed obstructive–restrictive patterns [6]. These findings are consistent with evidence from chronic respiratory disease cohorts showing that 6MWD aligns with spirometry-based functional grading and captures real-world limitations that may not be fully explained by resting lung volumes alone [6]. Importantly, 6MWT offers an "integrated" assessment of ventilatory mechanics, gas exchange, peripheral muscle function, symptoms, and cardiovascular response, which helps explain why it often tracks clinical status and patient-perceived disability beyond spirometry [5].

A key observation in our results was the exercise-induced fall in oxygen saturation and its negative correlation with spirometric impairment, suggesting that patients with lower lung function tended to develop greater exertional hypoxemia during submaximal activity [2]. In interstitial lung disease (ILD), prior observational work has shown that 6MWD is associated with FVC and that desaturation parameters add clinically relevant information, especially when diffusion limitation and ventilation–perfusion mismatch are prominent [2, 3]. Our findings parallel these ILD data in the sense that functional capacity and oxygen behavior during 6MWT moved in the same direction as physiologic severity, supporting the concept that 6MWT-derived metrics can complement spirometry when evaluating disease burden and counseling patients [2]. At the same time, we recognize that the strength of association varies by phenotype; for example, some ILD studies report only weak correlations between 6MWD and spirometric indices, indicating that factors such as pulmonary vascular involvement, comorbid anemia, deconditioning, and symptom tolerance can weaken a simple lung-function–to-walk-distance relationship [3]. Therefore, interpreting 6MWT as a "functional marker" is most

accurate when it is framed as a composite reflection of disease impact rather than a direct surrogate of any single spirometric variable [3, 5].

Our results also align with literature in chronic obstructive pulmonary disease (COPD), where 6MWD is repeatedly linked to clinically important outcomes and has been embedded in multidimensional indices (e.g., BODE) that predict morbidity and mortality more effectively than FEV_1 alone [7]. Contemporary cohorts continue to demonstrate that lower 6MWD identifies patients with worse symptom burden, greater desaturation, and higher risk of adverse outcomes, reinforcing the test's prognostic relevance in obstructive disease [8]. Beyond baseline risk stratification, 6MWT is widely used to assess response to pulmonary rehabilitation and longitudinal change; large COPD datasets show that walk performance improves in many patients after rehabilitation and that baseline characteristics influence response, which supports using 6MWT for monitoring functional recovery alongside spirometry [9]. Notably, post-viral and post-COVID populations have also highlighted a similar pattern: reduced spirometry and reduced exercise capacity frequently coexist months after infection, underscoring the value of pairing spirometry with a field test to quantify persistent limitation and guide rehabilitation planning [10, 11]. From a practical standpoint, our findings support a workflow in which spirometry characterizes physiologic impairment (airflow obstruction/restriction) while 6MWT provides an immediately interpretable, patient-centered measure of "what the lungs can do" during daily-life intensity activity [5, 10].

Despite supportive findings, several considerations are important for interpretation and generalizability. First, 6MWD is influenced by age, sex, height, weight, motivation, learning effect, corridor length, standardized encouragement, and comorbidities; therefore, strict adherence to technical standards and consistent test conditions are essential to reduce measurement variability and avoid overestimating physiological relationships [4, 5]. Second, spirometry itself may not fully represent disease severity in phenotypes dominated by diffusion limitation, dynamic hyperinflation, pulmonary vascular disease, or skeletal muscle dysfunction; accordingly, discordance between spirometry and 6MWT can occur and should be viewed as clinically informative rather than as a "failure" of either test [3, 7]. Third, external validity depends on the diagnostic mix; studies in surgical lung resection candidates have even reported no meaningful correlation between 6MWD and spirometry, emphasizing that the 6MWT may not substitute for spirometry when precise pre-operative pulmonary function estimation is needed [4]. Finally, our study design was observational; while correlations support association, they do not prove that spirometric impairment is the sole driver of functional limitation [6]. Future prospective work should incorporate diffusion capacity, symptom scores, physical activity measures, and longitudinal follow-up to determine whether 6MWT changes track spirometric change over time and whether combined models improve prediction of exacerbations, hospitalization, and health-related quality of life in the Indian clinical context [8, 9].

Conclusion: This prospective study demonstrated a significant association between six-minute walk distance and key spirometric parameters, particularly FEV_1 and FVC, indicating that the 6MWT reliably reflects functional impairment in patients with chronic respiratory disease. Exercise-induced oxygen desaturation showed an inverse relationship with lung function, highlighting its value in identifying patients with greater physiological limitation during daily activities. Given its simplicity, safety, and reproducibility, the 6MWT serves as a useful functional marker that complements spirometry. Incorporating both assessments provides a more comprehensive evaluation of disease severity and functional capacity in routine clinical practice.

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Table 1: Spirometric parameters of the study participants

Parameter	Measured	% Predicted
FEV_1 (L)	1.92 ± 0.61	63.5 ± 18.2
FVC (L)	2.48 ± 0.74	69.1 ± 17.6
FEV_1/FVC (%)	72.4 ± 11.8	—

Table 2: Various 6MWT parameters among the study members

Parameter	Mean ± SD
6MWT (m)	392 ± 86
Baseline SpO_2 (%)	96.2 ± 1.8
Post-test SpO_2 (%)	92.8 ± 3.6
Oxygen desaturation (%)	3.4 ± 2.1
Borg dyspnea score (post-test)	4.2 ± 1.6

Table 3: Correlation between 6MWD and spirometric parameters among the study members

Parameter	Correlation coefficient (r)	P value
6MWD vs FEV_1 (% predicted)	0.62	<0.001
6MWD vs FVC (% predicted)	0.58	<0.001
6MWD vs FEV_1/FVC	0.41	0.002
Oxygen desaturation vs FEV_1	−0.46	<0.001